Draft Arterial ITS Plan for the Phoenix Metropolitan Region

By
Arterial ITS Working Group
MAG Intelligent Transportation Systems Committee

September 7, 2006

MARICOPA ASSOCIATION of GOVERNMENTS

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1. Purpose

This Plan has been developed by the Arterial Intelligent Transportation Systems (ITS) Working Group of the MAG ITS Committee. It will serve as the guiding document for planning and for implementing ITS applications on the arterial street system in the Phoenix metropolitan region over the next ten years. The ITS applications addressed in this Plan are collectively referred to as Arterial ITS. It describes how funds dedicated for Arterial ITS, in the 2004 MAG Regional Transportation Plan (RTP), would be utilized for improving Arterial ITS infrastructure and operations. The RTP allocated a total of $50 million for Arterial ITS in the overall 20-year Arterial Life Cycle Program. However, due to the urgency for needed improvements on arterials, these funds have been accelerated to the first ten years of the Program.

The following information is provided in this Plan:

(1) The link between the Regional ITS Architecture and Arterial ITS.
(2) A vision for future arterial ITS infrastructure and operations in the region;
(3) A description of the current system;
(4) A process for migrating from the current system towards the regional vision through regional investments in Arterial ITS over the next ten years; and

This Plan would also serve as a useful reference when MAG member agencies update or develop local ITS plans.

2. Goals and Objectives

The goals and objectives for Arterial ITS can be summarized as follows:

- Better utilization of the arterial systems by using effective arterial management techniques
- Management of traffic flow affected by incidents, special events and other abnormal conditions
- Delivery of integrated travel information to travelers via multiple media
- Interagency data sharing to promote arterial operation optimization
- Archival of traffic data for operations, planning and research purposes
- Identification of feasible strategies and resources to maintain arterial traffic management Infrastructure

To achieve the above, the following measurement goals have been adopted from Regional Concept of Transportation Operations:

- Limit the percentage increase in average arterial travel time to less than the percentage increase in VMT/traffic volume
- Reduce incident response and clearance time
- Reduce transit travel time and increase schedule adherence
- Improve center-to-center communication
- Provide effective travel information and improve public awareness

3. The Need, Justification and the Vision for Future Arterial ITS Infrastructure and Operations

The urban arterial street system in the region carries nearly half of all daily travel that occurs in the region. They connect urban business centers with suburban residential areas, provide access to the urban freeway system and also provide alternative routes to freeways. The arterial street system, therefore, plays an important role in the regional economy and growth.

There are limited options for meeting the rapidly increasing demand for travel on the transportation network and at the same time maintaining a high level service. They are: (1) The road system's capacity can be increased to keep pace with increasing demand; (2) The system can be made more efficient through operational improvements; or (3) A combination of both (1) and (2). Expanding capacity of a street network or street widening is a very costly and time consuming proposition that requires right-of-way acquisition, and in built-up areas would negatively impact street front businesses and residential areas. It has been observed that the application of Arterial ITS to a street network can significantly improve operations, in some cases increasing efficiency by as much as twenty percent. Arterial ITS provides the ability to continuously monitor the street system, via cameras and sensors, and thus enable timely responses to changing patterns of traffic flow, or to provide timely advisories to motorists.

The experience of local agencies have proven the value of Arterial ITS. The enhanced traffic management capabilities provided by Arterial ITS have been very helpful for local agencies to better manage complex traffic management tasks – such as special events that draw large crowds. The following are a few examples:

City of Scottsdale's traffic and police using Arterial ITS for managing traffic during the FBR Open Golf Tournament;
City of Phoenix's traffic and police using the Downtown Traffic Management System during all downtown sporting events.

A well planned and regionally integrated Arterial ITS would help accomplish the following:

1. Improve the ability to monitor arterial traffic conditions and for better utilization of existing roadway capacity,
2. Provide traveler information, warnings and advisories,
3. Respond to special events and incidents,
4. Better coordination with any adjacent freeway operations,
5. Improved mobility and safety.

4. The Range of Arterial ITS Applications

Many ITS technologies have been successfully implemented on the arterials street system in the MAG region and also in other urban regions in the U.S. These applications are briefly described next.

4.1 Traffic Management

- Traffic monitoring by using surveillance cameras, detectors or other techniques to obtain traffic volume, speed, travel time, visual images, etc.
- Traffic control by changing signal timing, coordinating traffic signals between and within different jurisdictions, diverting traffic with Dynamic Message Signs (DMS), and Highway Advisory Radio (HAR).
- Traffic Signal Preemption for Emergency Vehicles
- Manage traffic based on planned maintenance and construction events as well as special events

4.2 Transit Operations Support

- Transit Signal Priority to give priority to transit vehicles when approaching signalized intersections
- Advanced Vehicle Location (AVL) in transit vehicles to provide data for operations

- Computer Aided Dispatch (CAD) systems to dispatch transit vehicles based on needs and availability

4.3 Interagency Data Sharing and Control

- Planned maintenance and construction events
- Signal Timing Plans
- Closed Circuit Television (CCTV) images
- Travel time, travel speed, volume, etc.
- DMS Status
- Incident Information Sharing

4.4 Integrated Traveler Information

- Utilize different media such as web service, DMS, HAR, 511, in-vehicle navigation, personal information access, TV channel, etc.
- Provide current Traffic condition with historical information, such as speed, travel time, expected delay, etc.
- Provide information for On-going incidents
- Provide information on planned maintenance and construction events as well as special events
- Provide location and availability of parking spots of the public/private parking facilities.
- Transit real-time schedule
- Severe Weather Warning
- Alternative Routes

4.5 Archived Data Management

- Provide historical information as reference for daily operation
- Archive traffic and incident data for planning purpose
- Archive traffic and incident data for research purpose

4.6 Incident Management

- Respond to traffic incidents on the arterial system, prevent secondary crashes and minimize traffic delay

4.7 Freeway-Arterial Coordinated Operations

- Coordinate the arterial and freeway operations where significant on-ramp/off-ramp traffic exists
- Integrated Corridor Management (ICM) helps improve the overall corridor performance by managing major arterials and freeways on the same corridor.

5. Regional ITS Architecture and Arterial ITS

The Regional ITS Architecture for the MAG region was developed as part of the 2001 MAG ITS Strategic Plan Update (See Fig 1). It provides a common framework for planning, defining, and integrating intelligent transportation systems and is based on the National ITS Architecture. It is also a federal requirement that all federally funded ITS projects conform to a defined regional ITS architecture. A key goal of developing ITS applications based on system architectures is to support interoperability of the various applications at both national and local levels. The current Regional ITS Architecture is a product that reflects the contributions of a broad cross-section of the ITS community (transportation practitioners, systems engineers, system developers, technology specialists, consultants, etc.). By recognizing the future needs and the vision for ITS in the MAG region, the Regional ITS Architecture has served as a key reference document and the "compass" for guiding future ITS implementation in the region.

The Regional ITS Architecture defines five subsystems: the Roadside (or Field) Subsystem, the Traveler Subsystem, the Vehicle Subsystem, the Center Subsystem and the Communications Subsystem as shown in Figure 1. The current architecture includes both freeway and arterial street systems. The ITS infrastructure on the urban freeway system are mature and performs functions such as monitoring traffic, collection of traffic and incident data, traffic management, traveler information dissemination etc. The urban freeway system carries an estimated 40 percent of the total daily vehicle miles of travel (DVMT) that occur on the regional surface transportation system. The urban arterial system carries an estimated 47 percent of DVMT. Residents in the region would benefit significantly from improved arterial traffic management infrastructure operations, as many trips made in the region traverses both these systems.

Over the years local agencies have implemented a number of arterial ITS elements. They include: centralized traffic signal systems, traffic signal preemption systems for emergency vehicles, adaptive traffic signal control (test carried out in Tempe), Traffic Management Centers etc. The region's rapid growth is leading to greater demands by the community for a more efficient and safer arterial street system. Despite the many improvements that have been made through Arterial ITS applications, there is room for further improvement and expansion of existing systems. The MAG Regional Concept of Transportation Operations (RCTO), adopted in 2003, identified the potential for improvement in traffic operations at Local, Local/Regional and at Regional levels (see Figures 2a and 2b). A number of initiatives recommended in the RCTO refer to necessary improvements in arterial operations. Many of these initiatives are currently being carried out through AZTech, a regional collaboration. These and other initiatives would benefit much from Arterial ITS infrastructure improvements. It is anticipated that future arterial ITS projects that result from this Plan would address these infrastructure needs.

A number of new steps are recommended for inclusion in the MAG project programming process.

1. All regionally significant Arterial ITS projects would be required to comply with the currently defined Regional ITS Architecture (a current federal requirement). New projects would consist of ITS elements that would fall within the five subsystems described earlier.

2. All Arterial ITS projects applications would be required to provide information explaining linkages to the Regional ITS Architecture through ITS User Services and ITS Market Packages (a current requirement in the MAG process). The MAG project programming process described in Section 7 shows what information will be sought for Arterial ITS projects. This information will be utilized to maintain the Regional ITS Architecture.

By developing both the Freeway Management System (FMS) and Arterial ITS infrastructure together, the region will draw closer to the vision of a well integrated regional ITS infrastructure in the future.

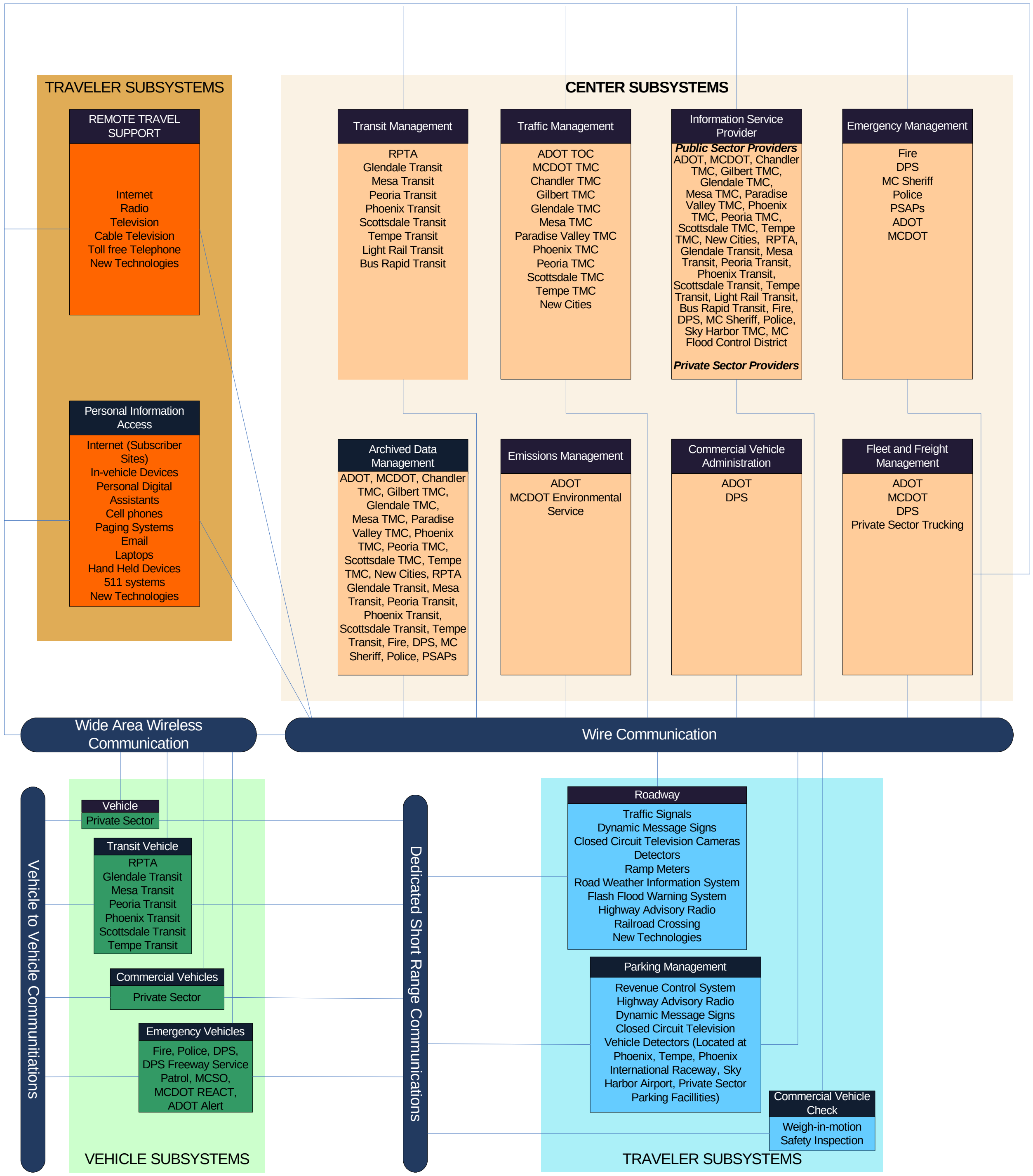


Figure 1 Current Regional ITS Architecture Framework

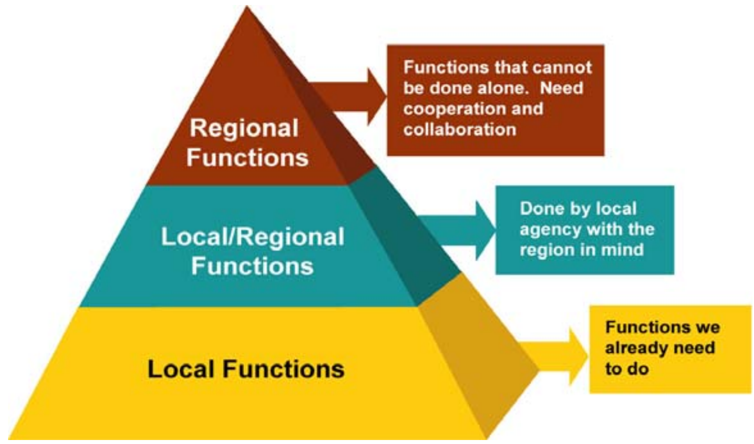
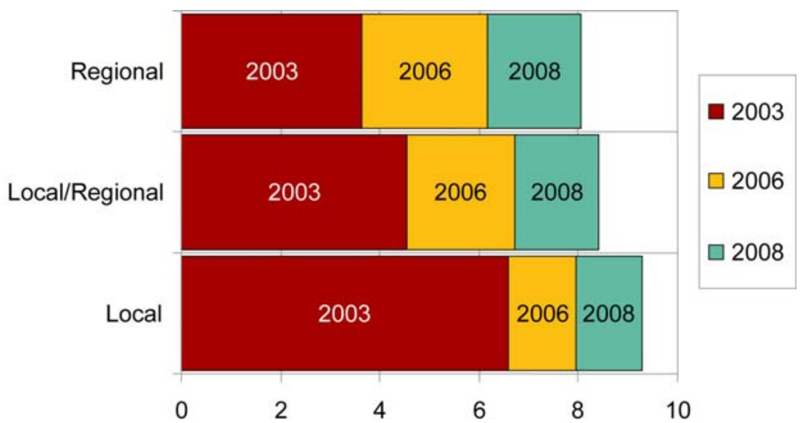


Figure 2(a) Operations at Local, Local/Regional and Regional Functions



Note: 10 on X-Axis reflects perfect operations

Figure 2(b) Regional Operations: 2003 Status and Goals for 2006 & 2008

6. Arterial ITS Components

For the purpose of this Plan, an arterial ITS component is defined as either a field device or an entire subsystem that provides a specific function. The following is a list of ITS components that fall within our definition of Arterial ITS. In the context of ITS Architecture some of these components are Subsystems (S) and others are Terminators (T).

- Traffic Management Centers/Transit Management Centers (S)
- Traffic Signal and Signal Systems (S)
- Communication Network (S)
- Traffic Surveillance Systems (S)/Closed Circuit Television Cameras (T)
- Dynamic Message Signs (T)

- Rail Road Crossing Signals (T)
- Automated Vehicle Location Devices on Transit Vehicles (T)
- Highway Advisory Radio, 511 traveler information hotline (S)
- Computer Aided Dispatch (S)
- Traffic Signal Preemption Systems (S)
- Incident Management System (S)
- Road Closure Warning System (S)
- System Detectors (T)
- Parking Management System (S)

6.1 Benefits of Arterial ITS Applications

- Reduce congestion and delays
- Improve incident response and clearance
- Increase traveler awareness and provide alternative routes and modes
- Improve utilization of physical capacity
- Encourage interagency coordination

One of the examples of Arterial ITS applications in MAG region is Scottsdale's Indian School Road ITS project. The project was deployed in 2002 along the three-mile Indian School Road corridor, between 64th Street and Pima Road, involving 14 intersections. The average daily traffic volumes along the corridor range from approximately 20,000 to 40,000 vehicles per day on the eastern end of the corridor.

The major ITS elements implemented include:

- 5 Closed-circuit television (CCTV) surveillance cameras to observe traffic conditions in real-time.
- Centralized traffic signal control system that allows remote modifications to traffic signal timing plans.
- 6 Roadside Dynamic Message Signs (DMS) for providing information to travelers.
- The Traffic Management Center (TMC) that provides a focal point for command and control.
- Intersection traffic detectors that provide data needed by the computerized traffic signal control units.
- Different types of vehicle detection technologies such as radar, video and inductive loop detectors

After the project was completed and in operation for 6 months, a study was conducted to evaluate the benefits gained by the project. The following summarizes the benefits:

- Improved Regular operations
    - ➢ Enable more frequent strategic signal timing plan updates on both individual intersection and along corridor to fit the ever-changing travel pattern.

- Travel time and delay do not indicate consistent savings although the trend shows that the travel time on this 3-mile segment can be reduced up to 64 seconds. With the growing travel, it is reasonable to say that the project prevents the congestion from getting worse.
- Reduce time lags for strategic signal timing update in response to the change of traffic patterns from 135 minutes to 35 minutes in the first round of signal modifications.
- It only takes 65 minutes to complete all the three rounds of traffic signal timing updates.

- Improved Incident, special event and emergency operations
  - Reduced the need for police field officers from 50-55 to 24 in field and 1 in TMC in Barrett-Jackson auction and the Phoenix Open Professional Golf Association.
  - Elimination of the lag time between notification and intervention
  - Improved surveillance accuracy and information interpretation
  - Decision-making based on an area-wide, coordinated perspective, rather than a localized, uncoordinated perspective.

- Experience in applying ITS technologies
  - CCTV cameras are very useful to identify the problems in traffic flow, information confirmation and performance observation.
  - DMS can convey the traffic condition to the travelers, even change their routes, and thus reduce congestion. The position of the DMS should be far away enough from the 'HOT spots' to allow time for travelers to react.
  - Inductive Loop detectors outperformed radar and video detectors in data quality.

- Estimated Annual community benefits (See Tables 1 through 6)

Table 1 Annual Community Benefits of Strategic Corridor Timing Plan Updates

Type of Benefit	Estimated Annual Reduction	Estimated Annual Dollar Value
Person delay	5,477 hours	$78,324
Fuel consumption	5,477 gallons	$8,216
Emissions	103 pounds	$6,883
Total		**$93,423**

Table 2 Annual Community Benefits of Additional Strategic Timing Plan Updates at Individual Intersections

Type of Benefit	Estimated Annual Reduction	Estimated Annual Dollar Value
Person delay	9,167 hours	$119,171
Fuel consumption	4167 gallons	$6,250
Emissions	1,208 pounds	$1,426
Total		**$126,847**

Table 3 Annual Community Benefits from Tactical Day-to-Day (Recurring) Congestion Timing Plan Modifications

Type of Benefit	Estimated Annual Reduction	Estimated Annual Dollar Value
Person delay	152,778 hours	$1,986,113
Fuel consumption	69,445 gallons	$104,168
Emissions	20,139 pounds	$23,764
Total		**$2,114,045**

Table 4 Annual Community Benefits from Barrett-Jackson/Phoenix Open Hot Spot Timing Plan Modifications

Type of Benefit	Estimated Annual Reduction	Estimated Annual Dollar Value
Person delay	155 hours	$2,015
Fuel consumption	78 gallons	$117
Emissions	10 pounds	$12
Total		**$2,144**

Table 5 City Police Labor Savings

Number of Field Police Officers Reduced Per Day	Total Person-Hours Saved Over 12-Day Phoenix Open/Barrett-Jackson time Period	Hourly Wage Rate for Field Police Officers	Total Dollar Value of Labor Savings
31	2,976	$36	$107,136

Table 6 Annual Community Benefits from Tactical Construction and Incident-Related Traffic Management

Type of Impact and Benefit	Estimated Annual Reduction	Estimated Annual Dollar Value
Traffic Signal Timing Modifications		
Person delay	612 hours	$7,943
Fuel consumption	278 gallons	$417
Emissions	81 pounds	$96
VMS Postings		
Person delay	1,558 hours	$20,254
Fuel consumption	779 gallons	$1,169
Emissions	226 pounds	$267
Total		**$30,146**

7. Status of Arterial ITS infrastructure in the region

7.1 Inventory of ITS Elements in Jurisdictions (July 2006)

Table 7 provides a complete inventory of arterial ITS elements implemented in MAG jurisdictions as of July 24, 2006.

Table 7 Inventories of ITS Elements in the MAG Region (July 24, 2006)

		ADOT	Chandler	Mesa	Goodyear	Glendale	Peoria	Scottsdale	Surprise
Inventory Item	**Units**	**Response**							
Traffic Management Center (Yes / No)		Yes	Yes	Yes	No	Yes	No	Yes	No
Centrally Controlled Signal System (Yes/ No)		Yes	Yes	Yes	No	Yes (partially)	No (Pending Installation)	Yes	No
a. If yes to 2. Traffic Signal System Manufacturer		Siemens	i2TMS	Econolite & KHA		i2TMS	i2TMS (Pending Installation)	Transcore	
Signal Controllers with wireless communications	Number	0	2	30	0	0	0	None	0
Traffic Signals	Number		186	365	30	185	72	276	23
Synchronized Signals	Number		182	361	0	150	65	276	7
a. Signals Synchronized by Signal System	Number	12	167	361	0	0	0	276	0
b. Signals Synchronized by Time Based coordination(TBC)	Number	0	15	361	0	150	65	0	7
Isolated Signals	Number		4	4	32	2	7	None	1
Transit Priority Signals	Number	0	1	0	0	0	0	None	0

		ADOT	Chandler	Mesa	Goodyear	Glendale	Peoria	Scottsdale	Surprise
Inventory Item	**Units**	**Response**							
Are Signals Synchronized with Adjacent Cities (Yes/ No)			Yes	Yes	No	Somewhat	YES/ GLENDALE	None	No
Emergency Vehicle Preemption at Traffic Signals	Number		176	285	30	140	40	220	0 with 16 to be activated with in a month
a. Vendor Name for Emergency Vehicle Preemption	3M / TOMAR / Both / Other		All 3M discriminators All Tomar emitters	3M	3M	TOMAR	3M	3M	TOMAR
Closed Loop System (Yes / No)			No	No	No	No	NO	No	No
System Detectors/ Traffic Count Stations	Number	200	0	168/33	0	14	7/ 7MORE PENDING	33	0
Fixed CCTV Cameras	Number	125	6	29	0	15	1	51	0
Portable/ Wireless CCTV cameras	Number	0	1	0	0	8	0	1	0
Fixed/Portable Dynamic Message Signs	Number	65	1	4	0	0	2	11	0
Dynamic Message Sign Trailers	Number	8	8	0	0	8	0	4	0
Fiber Optic Backbone	Miles	174	19	34	0	19	9	18	0

		Avondale	Phoenix	TEMPE	MCDOT	Gilbert	Queen Creek	Buckeye	El Mirage
Inventory Item	**Units**	**Response**							
Traffic Management Center (Yes / No)		No	Yes	No	Yes	Yes (unmanned)	No	No	No
Centrally Controlled Signal System (Yes/ No)		Yes	Yes	Yes	Yes	Yes	No	No	No
a. If yes to 2. Traffic Signal System Manufacturer		Naztech	Transcore	Transcore	i2TMS	Icons			
Signal Controllers with wireless communications	Number	30	15	0	30	67	0		
Traffic Signals	Number	30	979	190	130	127	2	3	2
Synchronized Signals	Number	11	979	185	44	86	0	0	0
a. Signals Synchronized by Signal System	Number	1 1	622	185	40	86	0	0	0
b. Signals Synchronized by Time Based coordination(TBC)	Number		357	185	4	33	0	0	0
Isolated Signals	Number	19	0	0	86	8	2		
Transit Priority Signals	Number	0	0	0	0	0	0	0	0

		Avondale	Phoenix	TEMPE	MCDOT	Gilbert	Queen Creek	Buckeye	El Mirage
Inventory Item	**Units**	**Response**							
Are Signals Synchronized with Adjacent Cities (Yes/ No)		No	Yes	Yes	Yes	Yes	No		
Emergency Vehicle Preemption at Traffic Signals	Number	22	19	190	15	119	0	0	0
a. Vendor Name for Emergency Vehicle Preemption	3M / TOMAR / Both / Other	TOMAR	TOMAR	3M	Both & others	Tomar Strobecom II	TOMAR (spec for new signals)		
Closed Loop System (Yes / No)		No	No	No	No	No	No	No	No
System Detectors/ Traffic Count Stations	Number	0	70	20	0	0	0		
Fixed CCTV Cameras	Number	0	10	0	16	262	0		
Portable/ Wireless CCTV cameras	Number	0	0	0	0	0	0		
Fixed/Portable Dynamic Message Signs	Number	0	7	0	0	4 (2/2)	0		
Dynamic Message Sign Trailers	Number	4	0	0	20	2	0		
Fiber Optic Backbone	Miles	0	20	0	7	9	0		

Inventory Item	Units	Apache Junction	Carefree	Cave Creek	Fountain Hills	Gila Bend	Gila River IC	Litchfield Park
Traffic Management Center (Yes / No)		No	No	No	No	No	No	No
Centrally Controlled Signal System (Yes/ No)		No	No	No	No	No	No	No
a. If yes to 2. Traffic Signal System Manufacturer								
Signal Controllers with wireless communications	Number							
Traffic Signals	Number	15	0	1	7	0	0	0
Synchronized Signals	Number	0	0	0	0	0	0	0
a. Signals Synchronized by Signal System	Number	0	0	0	0	0	0	0
b. Signals Synchronized by Time Based coordination(TBC)	Number	0	0	0	0	0	0	0
Isolated Signals	Number							
Transit Priority Signals	Number	0	0	0	0	0	0	0

		Paradise Valley	Pima Maricopa IC	Tolleson	Wickenburg	Youngtown
Inventory Item	**Units**					
Traffic Management Center (Yes / No)		No	No	No	No	No
Centrally Controlled Signal System (Yes/ No)		No	No	No	No	No
a. If yes to 2. Traffic Signal System Manufacturer						
Signal Controllers with wireless communications	Number					
Traffic Signals	Number		0	8	0	0
Synchronized Signals	Number		0	0	0	0
a. Signals Synchronized by Signal System	Number		0	0	0	0
b. Signals Synchronized by Time Based coordination(TBC)	Number		0	0	0	0
Isolated Signals	Number					
Transit Priority Signals	Number	No	No	No	No	No

		Paradise Valley	Pima Maricopa IC	Tolleson	Wickenburg	Youngtown
Inventory Item	**Units**					
Are Signals Synchronized with Adjacent Cities (Yes/ No)						
Emergency Vehicle Preemption at Traffic Signals	Number		No	No	No	No
a. Vendor Name for Emergency Vehicle Preemption	3M / TOMAR / Both / Other					
Closed Loop System (Yes / No)		No	No	No	No	No
System Detectors/ Traffic Count Stations	Number					
Fixed CCTV Cameras	Number					
Portable/ Wireless CCTV cameras	Number					
Fixed/Portable Dynamic Message Signs	Number					
Dynamic Message Sign Trailers	Number					
Fiber Optic Backbone	Miles					

7.2 System Maintenance and Operations

System maintenance and operations are often identified as critical needs by local agency traffic operations staff. Insufficient resources for maintenance and operations could have a significant negative impact on the total efficacy of the arterial system. Arterial ITS requires regular maintenance and equipment replacement to ensure proper operation of equipment and minimize failures. Sophisticated systems utilized in Arterial ITS also require skilled staff to operate them. Due to lack of adequate funding, some of the existing ITS infrastructure in the region have become obsolete. The demand on staff skills has dramatically changed over the years. **Local agencies that request federal funds for new Arterial ITS projects or to advance or expand existing Arterial ITS must also plan and provide sufficient local agency resources to operate and maintain these systems**.

7.3 Traffic Management Center (TMC) Operations

The concept of traffic operations and management has changed over the last decade, primarily due to ITS applications such as closed-circuit TV (CCTV) cameras, Dynamic Message Signs and increased ability to communicate with traffic signals and other field devices. Traffic management strategies have changed from reactive traffic control measures to a more proactive approach to traffic control and monitoring.

In the Phoenix metropolitan region, many of the larger municipalities either have Traffic Management Centers (TMCs) or have plans for building one. Some TMCs are fully operational; others are in various planning stages. It is expected that all of the TMCs will be interconnected via a communications backbone referred to as the Regional Community Network (RCN). This would provide TMC operators and traffic engineers the ability to share camera images, DMS status and traffic signal system information and possibly share control, as needed to implement traffic responsive strategies to minimize delay and congestion. Table 8 provides a list TMCs that are fully operational as of August 2006.

Table 8 Traffic Management Centers Currently in Operation

	ADOT	**Chandler**	**Mesa**	**Glendale**	**Scottsdale**	**Phoenix**	**MCDOT**
TMCs	Yes	Yes	Yes	Yes	Yes	Yes	Yes

AZTech, the regional operations collaboration, is currently developing several white papers that address the day-to-day operational issues in the region. These include White Papers on: Center-to-Center Communications; Travel Information and TMC Operations. They have resulted from RTCO initiatives and will continue to serve as the detailed working plans to link the Arterial ITS Plan and daily operations. The following sections describe TMC functions as currently implemented in the region.

7.4 Day-to-day Operations

Most Traffic Management Centers in the region operate on a 12-hour schedule, five days a week, with the exception of ADOT's Traffic Operations Center (TOC), which operates 24 hours on all days of the week. The ADOT TOC also serves as the statewide operations center for ADOT. Within the MAG region, the ADOT TOC functions are mostly limited to the urban freeway system. The TOC staff helps coordinate with DPS and local agency TMC staff during major freeway crashes or incidents that impacts operations on the adjacent arterial system. The following typical functions occur daily at most TMCs in the valley.

- *Real-time traffic monitoring* using CCTV cameras and vehicle detection devices that detect the traffic flow rate and flow speeds. If problems are identified, TMC operators have the option to contact local radio and TV traffic reporters with detailed information, or post information on 511 via ADOT. Once information is posted on the 511 system it is available via the internet and is also accessible to mobile phone users. Where available, traffic advisory messages are posted on Dynamic Message Signs (DMS). More importantly, citizen requests can be addressed promptly. TMCs have, on a few occasions, received calls from drivers on cell phones with complaints about unusual delays due to signal timing. In certain instances that required rapid response, TMCs have been able to respond to the complaint while the driver was still on the phone.
- *Traffic management, including signal control* can be deployed quickly when an agency's operators have remote access to the signal system. Some cities have developed timing plans to match the traffic demand during most temporary events, such as accidents, incidents or detour routes. In the event that a construction project is longer than one day, semi-permanent timing plans can be implemented and adjusted when traffic conditions require modifications to the signal timing.
- *Incident Management - A traffic incident* can cause a greater delay to motorists than simple lane closures or recurring congestion. TMCs have the potential to become permanent command centers, with proper radio communications and a vast array of CCTVs. While Incident Management is not currently a standard practice, it could be further developed by integrating incident information from other agencies such as police/fire department and enhancing existing incident management operations.
- *Special Event Traffic Management* have brought ITS into the mainstream. Some of the special events in the valley bring as many as 150,000 people a day to the events. With ITS deployed in the field and TMCs, traffic engineers are able to support these large events with greater flexibility, and the results have been astounding. The need for Police officers at intersections has drastically reduced, making it safer for the officers and the driving public. Special signal timing plans have been developed to guide traffic into, and out of events in a much more orderly fashion. DMSs have been used to help direct drivers with special needs to their parking places. The deployments of ITS devices have made traffic control

dynamic, allowing better control of changing traffic conditions. In some cases, evacuation timing plans have been developed in case the need ever arises.

- *Data Archiving* has long been a function of traffic management. Studies on transportation safety, mobility and planning can make use of archived data. For example, archived travel time on freeways and arterials can be used to determine a base line measurement for delay. For planning purposes, archived traffic volume can help development restrictions. Accurate archived traffic are used to calibrate transportation demand models, traffic simulation models and refine optimization tools.
- Some cities are utilizing cameras in *Construction Management* to monitor roadway construction sites. Project managers have found cameras extremely useful for monitoring construction progress and the quality of work being accomplished.

7.5 Center-to-Center Communications

An expandable communications infrastructure provides the ability to increase the ITS capabilities. Most ITS communications today are being designed to utilize Internet Protocol (IP), which allows more flexibility on different communication systems. The deployments of fiber and radio devices all have the ability to handle IP communications which helps reduce the need to install point-to-point hardware between every ITS device. Figure 3 shows the planned center-to-center communications network in MAG region.

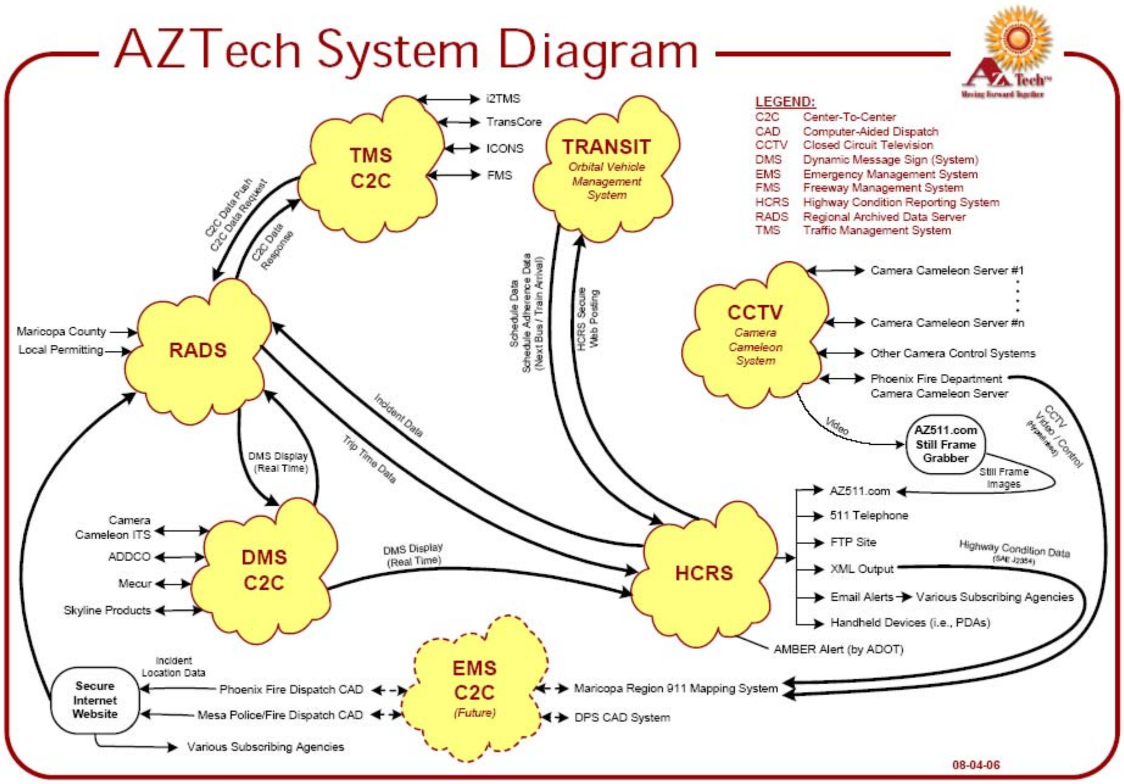


Figure 3 Center-to-Center Communications Diagram

- *Center-to-Center (C2C) communications* allows member agencies to monitor, maintain and/or even control other devices outside their own jurisdiction. The goal of C2C communications is to provide for seamless control of traffic and ITS devices, such as traffic signals, DMS, cameras and etc. Drivers expect to experience good traffic progression, regardless of what city they are driving in. Connecting TMCs with a robust communication infrastructure allows operators to monitor traffic across jurisdictional boundaries, adjust the timing of traffic signals at the borders, and also post advisory messages on DMSs on traffic conditions on adjacent arterials and nearby freeways. At present, some local TMCs share their camera images to monitor traffic conditions on adjacent jurisdictions so that they take actions to address the impact. Many other applications are still under discussion.
- *What data should be shared via C2C is always a topic of discussion.* What levels of control should one agency receive (or need) of another's agency's infrastructure is being discussed. Over the past year, ADOT, Scottsdale, and Maricopa County have shared camera control with few issues or concerns. Signal and DMS control may become necessary in the future, since no local municipality operates their TMCs on a 24/7 basis. There are many scenarios available to the region, and the should all be explored. One scenario is that neighboring cities could backup their signals systems on another municipality's signal system to provide redundancy. Currently, Paradise Valley's signal system is actually in City

of Scottsdale's database, With Paradise Valley having Remote Access. The cities of Phoenix, Tempe and Scottsdale (all three cities have the same TransCore signal system) could potentially have each city's database reside on one another's server for data protection, should any of the servers at a TMC fail.

8. Candidate Arterials for Arterial ITS program

The concept of "Smart Corridors" was included in the 2001 MAG ITS Strategy Plan Update and the 2003 MAG Regional Transportation Plan (RTP). This concept, developed around early to mid-nineties, was based on the premise that Arterial ITS strategies can be effectively implemented on a limited set of arterials that run across the region. It must be noted here that this idea was developed during the very early days of ITS and there was little actual experience to go by. However, the last ten years of Arterial ITS implementation in the MAG region have clearly demonstrated that traffic management practice at the local agency level is mostly a network optimization/management task than one that is focused on a few regional corridors.

Based on this experience, MAG member agencies are recommending that future Arterial ITS applications should not be focused on a limited set of "Smart Corridors". To accurately reflect this change in the traffic management philosophy, future MAG ITS planning documents will refer to "Smart Street Networks". The vision for future is that Arterial ITS applications would be geared towards addressing specific needs on the arterial system by taking into account local traffic patterns, street network and other related issues. Therefore, any arterial that carries heavy traffic volumes and/or have significant regional impacts may be considered in the project selection process of the Arterial ITS program.

9. Available Funds for Arterial ITS

Table 9 Arterial ITS funds available for programming

Fiscal Year	Available $ Millions	Already Programmed $ Millions	To be Programmed $ Millions
FY2008	5.38	2.94	2.44
FY2009	5.26	2.77	2.49
FY2010	5.29	3.25	2.04
FY2011	5.31	5.31	0.00
FY2012	5.34	0.00	5.34
FY2013	5.36	0.00	5.36
FY2014	5.39	0.00	5.39
FY2015	5.42	0.00	5.42
FY2016	5.44	0.00	5.44
FY2017	5.47	0.00	5.47
FY2018	2.22	0.00	2.22

The Arterial ITS Program is contained within the Arterial Life Cycle Program (ALCP) of the MAG Regional Transportation Plan. Table 9 shows the amounts of federal CMAQ funds that are available for programming in FY2008 through FY2018. All projects that are to be programmed in the Arterial ITS Program require a 30 percent local match. The local funding sources need to be explicitly specified. The following guidelines have been developed by the MAG ITS Committee for use in programming projects:

1. Each MAG agency may request a maximum of $1 million in federal funds per program year for one or more Arterial ITS projects that would involve either one or two agencies.
2. Arterial ITS projects of a regional nature, that involves at least 3 MAG agencies, may exceed the $1 million limit. For these projects the individual agency cost components would not be counted against the $1million max limit.
3. All projects would be subjected to the ITS Project Rating System and the process utilized for project selection and prioritization.

10. Arterial ITS Project Programming and Planning Process

As part of the MAG Transportation Improvement Program (TIP) process, member agencies will be requested to submit ITS project applications to MAG by the stipulated deadline for each new program year. For the next five-year TIP program cycle (FY2008-FY2012), project applications will be due to MAG on September 1st, 2006. Typically, the fifth year of the TIP is programmed – for the next cycle that would be FY2012. In the two previous TIP programming cycles the years 2008, 2009, 2010 and 2011 were programmed. However, due to a change in funding the Arterial ITS Program, additional funds have become available for programming projects in 2008, 2009, and 2010. Table 9 shows the total amounts available in each program year. The goal of the next TIP programming cycle would be to fully program Arterial ITS projects against the funds in 2008, 2009, 2010 and 2012. Arterial ITS projects that will be programmed in each successive program year, from 2008 through 2012 will be included in Appendix C of this document and will represent the MAG region's short-term Arterial ITS Implementation Plan.

For each project, member agencies will be requested to provide the following items for consideration:

1. Project description
2. Project budget
3. Major tasks
4. Timeline
5. General maintenance and operation plan and funding source
6. Arterial ITS functions supported by the project

7. Applicable ITS User Service, Market Packages from National ITS Architecture
8. Communications or data sharing with other agencies (if any)
9. Information flows, data flows (only for projects that exchange information with other agencies)
10. How the project development process will address the Systems Engineering Analysis (SEA) requirement. (The FHWA system engineering 'V' diagram guidelines are included in Appendix A).

An Excel-based project data form will be made available for submitting detailed project information on each of the topics listed above. Please see Appendix B for the MAG ITS Project Data Form. The ITS Committee members will review project data forms of candidate projects and assign subjective scores using Table 10 (ITS Project Rating System). The combined scores of committee members will be used to generate a preliminary ranking for all qualifying ITS projects.

The final step in this process would involve project presentations by the sponsoring agencies. The presentations will address the criteria listed in Table 10. The final project ranking will be determined by the MAG ITS Committee following project presentations and will follow a subjective ranking process that would also assign available federal funds for the projects recommended in each year programmed.

10.1 **Arterial ITS Project Selection Criteria**

Table 10 Arterial ITS Project Rating System

	Criteria									
Projects	Regional Mobility	Traffic Management	Incident Management	Transit Operations Support	Interagency Data Sharing	Integrated Traveler Information	Archive Data Management	Freeway-Arterial Operations	Maintenance and Operations Plan	Total
	10	20	10	10	10	20	10	10	15	115
1										
2										
3										
4										
5										

Note: Please refer to section 4 for the definitions of the criteria.

11. Arterial ITS Implementation Process

11.1 Project Development Process

To simplify the project administrative process, Arterial ITS program does not require member agencies to have project agreements with MAG. However, in order to conform to MAG RTP requirements and ensure timely progress of the arterial ITS projects, member agencies will need to report the project progress to MAG. The following list shows the milestones at which agencies need to notify MAG before project construction:

- Request project number from ADOT
- Submit Initial Design Concept Report (DCR) to ADOT / Perform System Engineering Analysis
- Approval of final DCR from ADOT
- Submit Initial Environmental Report to ADOT
- Submit Final Environmental Report to ADOT
- Obtain Environmental clearance from ADOT/FHWA
- Submit 30% preliminary plans, cost estimate and report to ADOT
  Completion of project level ITS architecture that defines applicable ITS User Needs, Information Flows, Data Flows, Market Packages – report to MAG as required for maintenance of Regional ITS Architecture
- Submit 60% preliminary plans, cost estimate and report to ADOT
- Utility and right of way clearance
- Submit 100% final plans, cost estimate and bidding schedule to ADOT with specified local funds
- Approval of the Intergovernmental Agreement (IGA) between ADOT and project sponsor
- Obligation authority of Federal funds from FHWA
- Advertised Date

For agencies that are considered self-certified by Federal Highway Administration, the above process may not need to go through ADOT. However, all agencies are required to notify MAG at the specified steps. This information is required by MAG for reporting on the Arterial Life Cycle Program. Figure 4 shows the ADOT project development process and the estimated process time for each step. It appears that it will take nearly one and a half years for an Arterial ITS project to go through the ADOT project development process before construction or implementation begins.

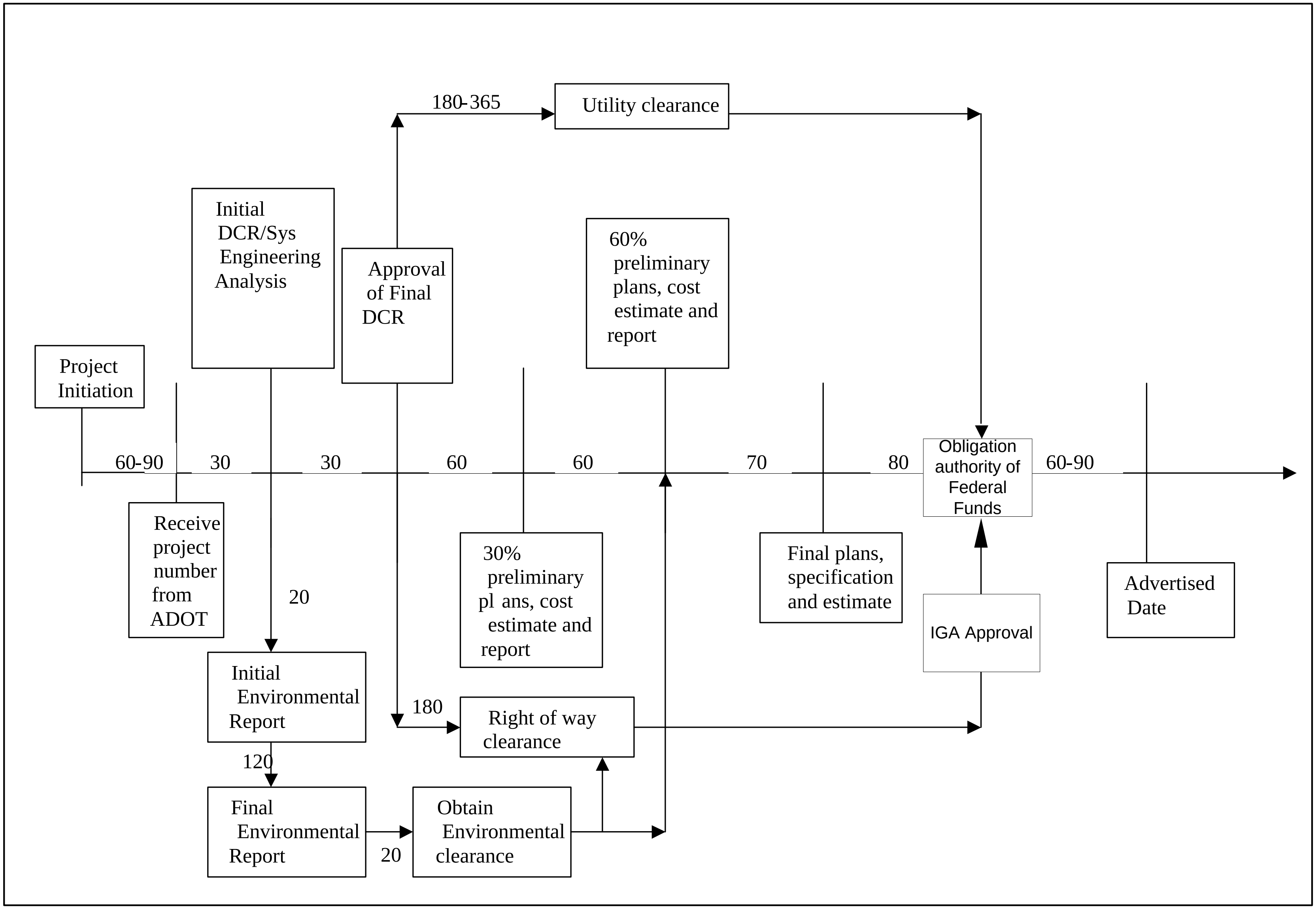


Figure 4. Project Development Process

11.2 Project Payments & Local Match

All projects in Arterial ITS program will receive funds on a cost reimbursement basis. These projects must have minimum local match of 30% (of total project cost), the cost reimbursement process will follow the current FHWA process for the administration of federally funded project through ADOT. A locally funded project may be credited toward the local match requirement ONLY if it can be demonstrated to be an integral component and a prerequisite for a new Arterial ITS project. Such locally funded projects must be identified in the local jurisdiction or Lead Agency CIP after November 1, 2002, and must be scheduled for completion prior to implementation of the new ITS project. The description of the proposed new ITS project must include the scope of the locally funded project and its function.

11.3 Progress Reports to MAG

Once the project begins construction, member agencies will be required to provide written progress reports every 6 months or based on the project tasks and timeline. The progress reports should be sent to the MAG ITS Program Manager. The report should list key project milestones reached and next steps etc. MAG will maintain a database on all Arterial ITS projects and their status. This information will also be available for review by member agencies via the MAG website.

11.4 Project Monitoring System

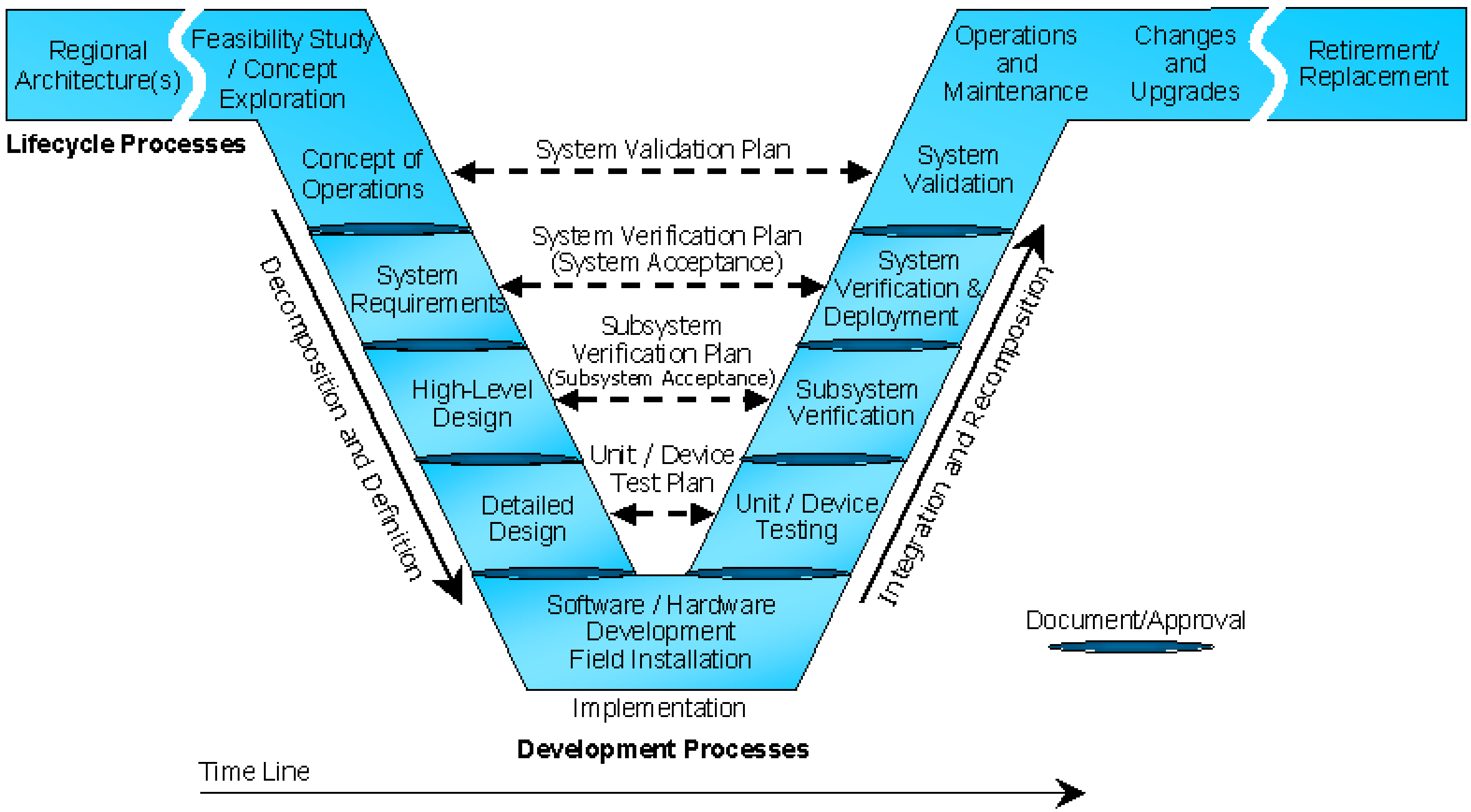
To assist member agencies and at the same time enable MAG to keep track of the progress of programmed projects, an automated project timeline monitoring system is proposed. This system will monitor project progress and send alerts to member agencies and MAG when a particular deadline in the process is approaching. MAG will work with member agencies in developing this system.

12. Arterial ITS implementation Plan

The arterial ITS funds that are currently available to be programmed in future years are shown in Table 9. It is anticipated that the FY2008-2012 TIP programming cycle will result in the identification of new ITS projects for 2008, 2009, 2010 and 2012, based on available funding. Table C1 in Appendix C shows a list of ITS projects currently programmed in the years FY2008 - FY2011.

New projects are expected to address the range of Arterial ITS applications described in Section 3.2. Arterial ITS projects that will be programmed in each successive program year, from 2008 through 2012 will be included in Appendix C of this document and will represent the MAG region’s short-term Arterial ITS Implementation Plan. To provide an accurate picture of Arterial ITS implementation in the region, this Plan would include all regionally significant local ITS projects that are locally funded.

Appendix A. System Engineering Analysis 'V' Diagram



NOTE: A guidelines document on Systems Engineering Analysis is being prepared by FHWA and MAG.

Appendix B. MAG ITS Project Data Form

A. Project Title & Sponsor	
Lead Agency	
Other Partnering Agencies	
ITS Project Title:	

B. Project Goals & Objectives

Project Goals:

Objectives:

C. Define ITS Subsystems, Achitecture Flows, Communications & Arterial ITS Applications

SELECT ITS Subsystems: http://www.iteris.com/itsarch/html/entity/paents.htm	Yes or No
Center Subsystem	
Traveler Subsystem	
Field/Roadside Subsystem	
Vehicle Subsystem	
Communications Subsystem	

Architecture Flows (Information flows among four subsystems: Traveler, Center, Roadside and Vehicle Subsystems)

From Subsystem	To Subsystem	Information flow

Communications: Required communications medium for data sharing with other agencies: (if applicable)

From agency	To agency	data flow	Medium	Existing?	Future (year) mm/yyyy	Check Date with Project Schedule

Arterial ITS applications	**Relevant Applications (ENTER: Yes or No)**	**Applicable ITS User Services Addressed http://www.iteris.com/itsarch/html/user/userserv.htm**	**Applicable ITS Market Packages http://www.iteris.com/itsarch/html/mp/mpindex.htm**
1. Traffic Management			
2. Transit Operations Support			
3. Interagency Data Sharing and Control			
4. Integrated Traveler Information			
5. Archived Data Management			
6. Incident Management			
7. Freeway-Arterial Operations			

D. Project Budget

(1) The total of all federal funds requested for ITS projects by any MAG member agency should not exceed $1 million per program year per agency.

(2) Joint projects that involve 3 or more agencies may exceed $1m in federal cost. Federal cost of each agency's component will not be counted against the $1m limit.

(3) There is no limit on the number of projects that may be submitted by an agency, but each project requires the 30 percent local cost match

	Federal Cost	Local Match (min 30%)	Total Cost
Amount			
Cost percentage			

E. Project Schedule

The following project milestones and schedules are based on a typical project procurement process. Please select applicable milestones. Some ITS projects may follow an abbreviated process. ENTER estimated time for such a process

Standard Project Milestones	Default Schedule for Process	Applicable Milestones (ENTER - Yes OR No)	Estimated Time (ENTER #Months)	Estimated Date (Enter> mm/yyyy)
Apply for ADOT project number				
Receipt of ADOT project number				
Initial DCR				
Final DCR				
30% Preliminary Plans, Cost Estimate and Report				
60% Preliminary Plans, Cost Estimate and Report				
Final Preliminary Plans, Cost Estimate and Report				

Environmental Clearance				
Utility Clearance				
Right-of-Way Clearance				
Approval of IGA				
Obligation authority of Federal Funds				
Advertised Date				
Final Deployment				

F. System Maintenance and Operations

Current staff resources available for ITS operations at the local agency (FTEs)	
Additional staff resources required for fully utilizing features added by project (FTEs)	
Estimated current annual ITS operations & maintenance budget	
Estimated additional annual operations & maintenance funds required for features added by project	
Estimated DATE from when required additional O&M funds will be available	

Other comments:

G.   Systems Engineering Analysis Requirement

Commitment to address the federal requirement for Systems Engineering Analysis:
Agency's intent to follow the process described in the 'V' diagram (See Appendix A of Arterial ITS Plan) during the project development process

The project sponsor or lead agency intends to incorporate the Systems Engineering Analysis in the scope of work for the project's Design Concept Report. The Systems Engineering Analysis will be carried out based on the forthcoming guidelines to be provided by FHWA (and made available at the MAG website).

Appendix C

Table C1. Short-term Arterial ITS Implementation Plan FY 2008 – FY 2011

FY	Agency	Projects	Federal Cost
2008	MAG	Arterial ITS Program	$2,436,100.00
2008	Mesa	Design and install fiber optic cable and end evises and complete connections at network hubs	$838,700.00
2008	Peoria	Construct Traffic Management Center	$990,200.00
2008	Surprise	Supply and install TMC equipment (phase 1)	$600,000.00
2008	Tempe	Construct Transportation Management Center	$510,000.00
2009	Glendale	Installation of fiber optic cable and video detection cameras	$439,200.00
2009	MAG	Arterial ITS Program	$2,489,800.00
2009	Maricopa County	Construct ITS Improvements	$1,000,000.00
2009	Mesa	Upgrade TMC equipment and purchase central components, field cameras and VMS	$396,600.00
2009	Paradise Valley	Install video detection systems	$89,600.00
2009	Phoenix	Construct regional ITS fiber optic backbone, phase B-1	$665,000.00
2009	Scottsdale	Construct smart corridor traffic control system	$180,800.00
2010	Chandler	Upgrade outdated TS1 signal equipment with TS2 signal equipment	$422,700.00
2010	Chandler	Upgrade, retrofit and integrate TMC equipment	$425,000.00
2010	MAG	Arterial ITS Program	$2,038,300.00
2010	Maricopa County	Design and construct TMC upgrade	$735,000.00
2010	Phoenix	Construct regional ITS fiber optic backbone, phase B-2	$665,000.00
2010	Scottsdale	Construct smart corridor traffic control system	$350,000.00
2010	Surprise	Construct fiber optic interconnection of traffic signals, cameras and VMS	$150,000.00
2010	Surprise	Construct fiber optic interconnection of traffic signals, cameras and VMS	$500,000.00

2011	Chandler	Install fiber optic cable for interconnecting traffic signals	$344,100.00
2011	Glendale	Purchase and Install Dynamic Message Signs	$156,000.00
2011	Goodyear	Implement traffic signal system, including installation of ITS backbone and communications equipment	$700,000.00
2011	Maricopa Co	Construct Dynamic Message Signs and fiber optic conduit and cable	$382,200.00
2011	Maricopa Co	Upgrade traffic signals, including CCTV facilities	$100,000.00
2011	Mesa	Install fiber optic communications and upgrade traffic signal controllers	$700,000.00
2011	Peoria	Design and construct extension to fibre optic backbone and install CCTV cameras	$700,000.00
2011	Phoenix	Construct regional ITS telecommunications expansion	$700,000.00
2011	Queen Creek	Design and construct/implement ITS hardware and software	$490,000.00
2011	Scottsdale	Install detection equipment, variable message signs and software	$102,500.00
2011	Surprise	Design and construct fiber optic cable interconnection of existing and future ITS facilities	$700,000.00
2011	Tempe	Install fiber optic connection between ADOT FMS backbone and signal cabinets at 22 interchanges	$100,300.00
2011	Tempe	Install wireless communications and CCTV monitoring at 26 intersections	$218,400.00